BUTTERFLY DIVERSITY OF ISAPUR WILDLIFE SANCTUARY, MAHARASHTRA, INDIA

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ABSTRACT

A study was conducted toevaluate the butterfly diversity in the Isapur Wildlife Sanctuary, Maharashtra. The study revealed presence 87 butterfly species dominated by family Nymphalidae (32.18 %), Lycaenidae (27.59 %) followed by Pieridae (27.59 %), Hesperiidae (18.75%) and Papilionidae (6.90 %).It appears that the butterfly abundance increased from monsoon to winter while decreased in the summer and pre monsoon due to possibly with the unavailability of nectar and the changes in temperature and humidity of the habitats concerned.The results of the study indicated that the Isapur Wildlife Sanctuary, Maharashtrahas a healthy environmental setup that accommodates rich butterfly diversity.

Keywords: *Butterfly, Diversity, Isapur Wildlife Sanctuary, Maharashtra.*

Introduction

One of the most interesting features of the earth is its extraordinary diversity that included about 10 million species (Whitaker and Captain (2008). This diversity is the base for sustenance of the ecosystems. Functional aspects of the species to provide goods and services for human well-being. Study of regional diversity enables the evaluation of the possible functional roles of the species (Wilson 1997). In this view, studies on species diversity are necessary to understand the effects of human development on the reliability and sustenance of an ecosystem.

The diversity of insects has been point out in many studies due to their provision of ecosystem services such as pollination, pest control, nutrient decomposition, and maintenance of species in the terrestrial and aquatic ecosystems (Koh and Sodhi 2004; Losey and Vaughan 2006). Among insects, butterflies are the most attractive elements of the universe. They perform prominent roles in pollination (Tiple et al. 2006; Tiple 2018). Adult butterflies are dependent on nectar and pollen as their food while the caterpillars are dependent on specific host plants for foliage (Nimbalkar et al. 2011). Butterflies are considered as the best indicators of the health of any specified terrestrial ecosystem (Thomas 2005; Bonebrake et al. 2010). Butterflies are therefore treated as an important model group in ecology and conservation (Watt and Boggs 2003; Ehrlich and Hanski 2004; Mukherjee et al. 2015).

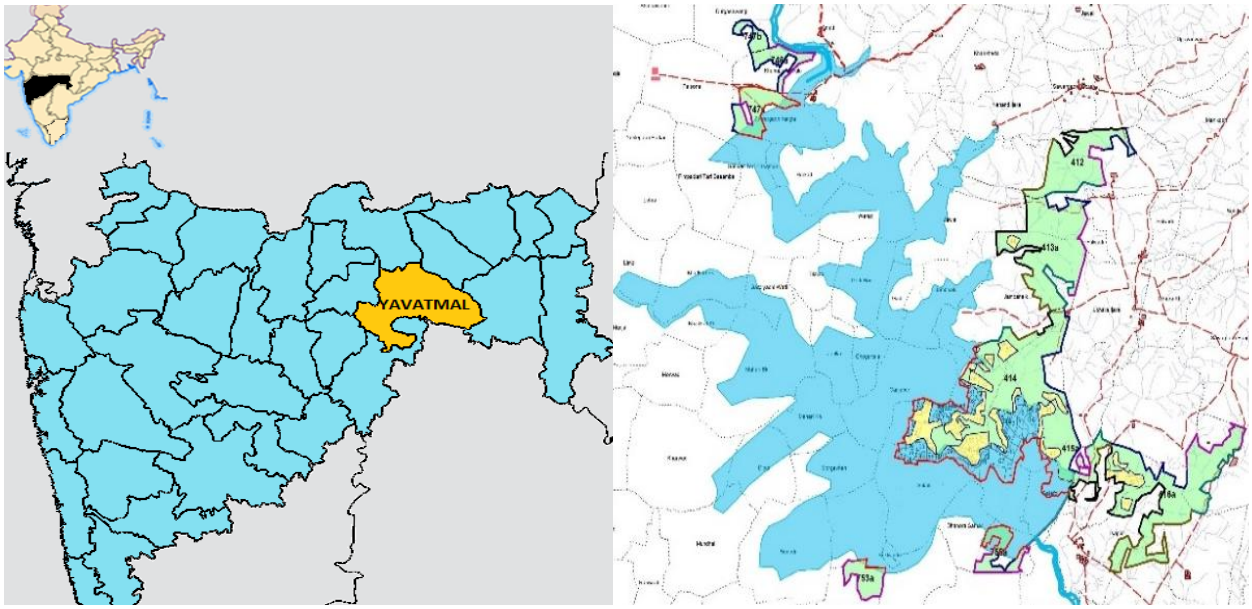
In this context, the conservation of butterflies is necessary to sustain varied kinds of ecosystem services for human well-being. In view of the essential ecosystem services rendered by butterflies and to promote conservation management, the present study was aimed at the estimation of the butterfly diversity in the Isapur Wildlife Sanctuary, Maharashtra, India. The results of the study are expected to supplement the necessary information on the conservation management and enhance the ecological roles of the butterfly species in the Isapur Wildlife Sanctuary and similar geographical regions.

Materials and methods

Study area

The Isapur Wildlife Sanctuary is a compact diversified blocks in Maharashtra State of India, with respect to biodiversity. Its healthy climate, mountainous terrain, rugged configuration and sudden fall in elevation are phenomenal. It spreads over in Yavatmal and Hingoli district. The area of the sanctuary is covered by Pusad Tahsil of Yavtmal district and Kalamnuri and Khanapur Tahsil of Hingoli district. It located among Pusad Division (E 77^0 25’50” and N 19^0 43' 35”) and Hingoli Division (E 77^0 21' 11” and N 19^0 51’35”) total area of forest is 2923.29 Ha. The climatic condition of this area is characterized by a hot

summer, well-distributed rainfall during the south-west monsoon season and generally dry weather during rest of the year. The cold season is from December to February(Yavatmal Gazetteer 2019).



Source: https://www.veethi.com/places/maharashtra-yavatmal-district-405.htm

Survey method

The butterflies were observed in the sampling sites for a period of 1 year between January 2019 and December 2019. During the survey, an efficient protocol was adopted. The survey was made using a "Pollard Walk" method (Pollard 1977; Pollard and Yates 1993) with necessary modifications. Study area was visited twice a month from early morning (7:00 AM) to afternoon (5:00 PM) during good weather periods.

Species identification

After detection, a specimen was photographed (Nikon D7100; Nikon Inc., Tokyo,Japan) and identified with the help of visible structural features. For identification and comparative studies of observed specimens, keys and methods suggested by Evans (1932), Wynter-Blyth (1957), Haribal (1992), Kunte (2000) and Kehimkar (2008) were adopted.

Data analysis

Species occurrence analysis was carried out by Microsoft excel program with using the following formulas. Relative Dominance (RD) of species was calculated as [RD=Ni × 100/Nt] where, Ni is number of individuals of species and Nt is total number of individuals all species (Basavarajappa 2006; Joshi 2014). Relative Occurrence (RO) of family was calculated as [RO= Ns × 100/Nt] where, Ns is number of species of each family and Nt is total number of all species (Basavarajappa 2006; Joshi 2014). Mean percent occurrence (M%) for month was calculated as [M% = Nm × 100 /Nt] where, Nm is number of individuals in each month and Nt is total number of individuals during complete study tenure (Basavarajappa 2006; Joshi and Tantarpale 2016). The mean values of the pooled species occurrence data were used to calculate the monthly diversity of and to categorize the local status of species.

The diversity assessment enabled highlighting the observed species richness pattern of the butterfly species. The diversity indices were quantified with the help of PAST Version 1.60 software (Palaeontological Asso., Norway; Hammeret al2001). The species diversity was calculated using Shannon diversity index that calculated as [$H^{'} = -\sum_{i=1}^{R} Pi \log Pi$], where Pi is proportion of the first species which is given by Pi= ni/N (Magurran 1988);species richness was obtained by using Margalef equation [R= (S-1)/ log N], Where, R is Index of species richness, S is Total number of species and N is Total No. of individuals (Magurran 1988);

while Species equitability was determined by equation of Pielou [J= N_1/N_0] where N_1 is Number of abundant species in the sample and N_0 is Number of species in the sample (Hammeret al2001). The similarity association matrix upon which the cluster based was computed using the nearest neighbour pair linkage algorithm of Euclidean distance index for presence and absence data (Hammeret al2001).

The differences between the diversity and evenness indices with species occurrence among different study months were statistically analyzed by using Analysis of variance (ANOVA). The statistical analyses were performed following Zar (1999) using the SPSS version 10 (SPSS Inc., Chicago, Il, USA; Kinnear and Gray 2000).

Results

During this study, 87 butterfly species under five families were observed in study area (Table 1). Based on value of butterfly relative dominance in study area, 37.93 % species was categorized as abundant species whereas 39.08 % species was common, 8.05 % species was frequent, 12.64% was occasional, and 2.30 % species was very rare. The maximum number of butterfly species were recorded under family Nymphalidae (32.18 %), Lycaenidae (27.59 %) followed byPieridae (27.59 %), Hesperiidae (18.75%) and Papilionidae (6.90 %) (Figure 1).

A dendrogram developed by Euclidean distance cluster analysis was observed to be multifaceted and showed variation in the level of similarity in the number of butterfly species in 12 months. The months with the minimum tomoderate number of species belong to one cluster, whereas the rest of the months with moderate to maximum number of species formed another cluster (Figure2).It appears that the butterfly abundance increased from monsoon to winter while decreased in the summer and pre monsoon due to possibly with the unavailability of nectar and the changes in temperature and humidity of the habitats concerned.

Observations on the monthly variations of butterfly abundances indicate peak from July to January while a low from February to May (Figure3). Mean percent abundance of butterflies was significantly different ($F = 80.23$, $df = 11$, $p < 0.05$); Shannon diversity values of butterflies were significantly different ($F = 102.3$, $df = 11$, $p < 0.05$); species evenness among different months was significantly different ($F = 109$, $df = 11$, $p < 0.05$) while species richness among the study months was significantly different ($F = 97.02$, $df = 11$, $p < 0.05$). A trend in mean% abundance, Shannon diversity, species richness and species equitability showed the contradictory patterns (Figure 5).

Table 1. Diversity of Butterflies during January 2019 to December 2019in the Isapur Wildlife Sanctuary, Maharashtra, India

Common Name	Scientific Name	IUCN status	Relative Dominance	Local Status
Family: Papilionidae				
Tailed Jay	*Graphium agamemnon* (Linnaeus, 1758)	NE	1.272	Common
Common Jay	*Graphium doson* (Felder and Felder, 1864)	NE	1.198	Common
Common rose	*Pachliopta aristolochiae* (Fabricius, 1775)	LC	1.087	Common
Crimson rose	*Pachliopta hector* (Linnaeus, 1758)	NE	1.026	Common
Lime Butterfly	*Papilio demoleus* (Linnaeus, 1758)	NE	1.444	Abundant
Common Mormon	*Papilio polytes* (Linnaeus, 1758)	NE	1.351	Abundant
Family: Pieridae				
Common Albatross	*Appias albino* (Fabricius, 1775)	NE	1.135	Common
Indian Pioneer	*Belenois aurota* (Fabricius, 1793)	NE	1.536	Abundant
Common Emigrant	*Catopsilia pomona* (Fabricius, 1775)	NE	1.004	Common
Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus, 1758)	NE	1.332	Abundant
Common Gull	*Cepora nerissa* (Fabricius, 1775)	NE	1.495	Abundant
Small salmon Arab	*Colotis amata* (Butler, 1870)	NE	0.112	Rare
Crimson Tip	*Colotis danae* (Fabricius, 1775)	NE	0.194	Rare
Small Orange Tip	*Colotis etrida* (Boisduval, 1836)	NE	1.147	Common
White Orange Tip	*Ixias Marianne* (Cramer, 1775)	NE	1.122	Common
Yellow Orange Tip	*Ixias pyrene* (Linnaeus, 1764)	NE	0.778	Occasional

Common Jezebel	*Delias eucharis* (Drury, 1773)	NE	1.326	Abundant
One Spot Grass Yellow	*Eurema andersoni* (Moore, 1865)	LC	1.581	Abundant
Three Spot Grass Yellow	*Eurema blanda* (Boisduval, 1836)	NE	1.096	Common
Small Grass Yellow	*Eurema brigitta* (Stoll, 1780)	LC	1.237	Common
Common Grass Yellow	*Eurema hecabe* (Linnaeus, 1758)	NE	1.412	Abundant
Spotless Grass Yellow	*Eurema laeta* (Boisduval, 1836)	NE	1.485	Abundant
Psyche	*Leptosia nina* (Fabricius, 1793)	NE	0.768	Occasional
Common Wanderer	*Pareronia valeria* (Cramer, 1776)	NE	1.218	Common
Family: Nymphalidae				
Tawny Castor	*Acraea violae* (Fabricius, 1775)	NE	1.068	Common
Angled Castor	*Ariadne ariadne* (Linnaeus, 1763)	NE	1.262	Common
Common Castor	*Ariadne merione* (Cramer, 1779)	NE	1.176	Common
Plain Tiger	*Danaus chrysippus* (Linnaeus,1758)	NE	1.517	Abundant
Striped Tiger	*Danaus genutia* (Cramer, 1779)	NE	1.386	Abundant
Common Crow	*Euploea core* (Cramer, 1780)	LC	1.571	Abundant
Baronet	*Euthalia nais* (Cramer, 1779)	NE	1.020	Common
Great Eggfly	*Hypolimnas bolina* (Linnaeus, 1758)	NE	1.163	Common
Danaid Eggfly	*Hypolimnas misippus* (Linnaeus, 1764)	NE	1.045	Common
Peacock Pansy	*Junonia almana* (Linnaeus, 1758)	LC	1.431	Abundant
Grey Pansy	*Junonia atlites* (Linnaeus, 1763)	NE	1.154	Common
Yellow Pansy	*Junonia hierta* (Fabricius, 1775)	LC	1.211	Common
Chocolate Pansy	*Junonia iphita* (Cramer, 1779)	NE	1.058	Common
Lemon Pansy	*Junonia lemonias* (Linnaeus, 1758)	NE	1.294	Abundant
Blue Pansy	*Junonia orithya* (Linnaeus, 1764)	NE	1.549	Abundant
Common Evening Brown	*Melanitis leda* (Linnaeus, 1758)	NE	1.364	Abundant
Great Evening Brown	*Melanitis zitenius*(Linnaeus, 1758)	NE	0.790	Occasional
Common Bush Brown	*Mycalesis perseus* (Fabricius, 1775)	NE	1.036	Common
Common Sailer	*Neptis hylas* (Linnaeus, 1764)	NE	1.014	Common
Common Leopard	*Phalanta phalantha* (Drury, 1773)	LC	1.457	Abundant
Blue Tiger	*Tirumala limniace* (Cramer, 1775)	NE	1.422	Abundant
Commander	*Moduza procris* (Cramer, 1777)	NE	1.246	Common
Painted Lady	*Synthia cardui* (Linnaeus, 1764)	NE	0.994	Common
Joker	*Byblia ilithyia* (Drury, 1773)	NE	0.985	Common
Common Three Ring	*Ypthima asterope* (Klug, 1832)	NE	1.249	Common
Large Three Ring	*Ypthima nareda* (Kirby, 1871)	LC	0.908	Frequent
Anomalous Nawab	*Polyura agrarian* (Linnaeus, 1764)	NE	0.736	Occasional
Towny Rajah	*Charaxes bernardus* (Fabricius, 1793)	NE	0.743	Occasional
Family: Lycaenidae				
Pointed Ciliate Blue	*Anthene lycaenina* (C. Felder, 1868)	NE	1.256	Common
Large Oak Blue	*Arphopala amantes* (Hewitson, 1862)	NE	0.730	Occasional
Dull Babool Blue	*Azanus uranus* (Butler, 1886)	NE	0.870	Frequent
Bright Babool Blue	*Azanus ubaldus* (Stoll, 1782)	NE	0.682	Occasional
Lime Blue	*Chilades lajus* (Stoll, 1780)	NE	1.562	Abundant
Gram Blue	*Euchrysops cnejus* (Fabricius, 1798)	NE	1.310	Abundant
Pea Blue	*Lampides boeticus* (Linnaeus, 1767)	NE	1.342	Abundant
Zebra Blue	*Leptotes plinius* (Fabricius, 1793)	NE	1.504	Abundant
Tailless Line Blue	*Prosotas dubiosa* (Semper, 1879)	NE	1.112	Common
Common Line Blue	*Prosotas nora* (Felder, 1860)	NE	1.227	Common
Guava Blue	*Virachola isocrates* (fabricius, 1793)	NE	0.720	Occasional
Dark Grass Blue	*Zizeeria karsandra* (Moore, 1865)	NE	1.374	Abundant
Lesser Grass Blue	*Zizina otis* (Fabricius, 1787)	NE	1.291	Abundant
Tiny Grass Blue	*Zizula hylax* (Fabricius, 1775)	NE	1.441	Abundant
Plum Judy	*Abisara echerius* (Moore, 1901)	NE	0.752	Occasional
Common Pierrot	*Castalius rosimon* (Fabricius, 1775)	NE	0.857	Frequent
Forget-Me-Not	*Catochrysops strabo* (Fabricius, 1793)	NE	1.399	Abundant
Plains Cupid	*Luthrodes pandava* (Horsfield, 1829)	NE	0.943	Frequent
Indian cupid	*Cupido lacturnus* (Godart, 1824)	NE	1.077	Common
Grass Jewel	*Freyeria trochylus* (Freyer, 1845)	NE	1.469	Abundant
Common Cerulean	*Jamides celeno* (Cramer, 1775)	NE	1.485	Abundant

Indian Red Flash	*Rapala airbus* (Fabricius, 1787)	NE	0.663	Occasional
Common Silverline	*Spindasis vulcanus* (Fabricius, 1775)	NE	1.530	Abundant
Rounded Pierrot	*Tarucus extricates* (Kollar, 1848)	NE	1.285	Abundant
Family: Hespiridae				
Brown awl	*Badamia exclamationis* (Fabricius, 1775)	LC	1.463	Abundant
Plain Banded Awl	*Hasora vita* (Cramer, 1780)	NE	0.867	Frequent
Rice swift	*Borbo cinnara* (Wallace, 1866)	NE	1.559	Abundant
Small branded swift	*Pelopidas mathias* (Fabricius,1798)	NE	1.339	Abundant
Conjoined Swift	*Pelopidas conjuncta* (Moore, 1878)	NE	0.959	Common
Paintbrush Swift	*Baoris farri* (Moore, 1878)	NE	0.886	Frequent
Common Straight Swift	*Parnara guttatus* (Bremer and Gray, 1853)	LC	1.205	Common
Indian Palm bob	*Suastus gremius* (Fabricius, 1798)	NE	0.979	Common
Dark Palm-Dart	*Telicota ancilla* (Moore, 1878)	NE	1.141	Common
Indian skipper	*Spialia galba* (Fabricius, 1793)	LC	0.819	Frequent
Grass Demon	*Udaspes folus* (Cramer, 1775)	NE	0.692	Occasional

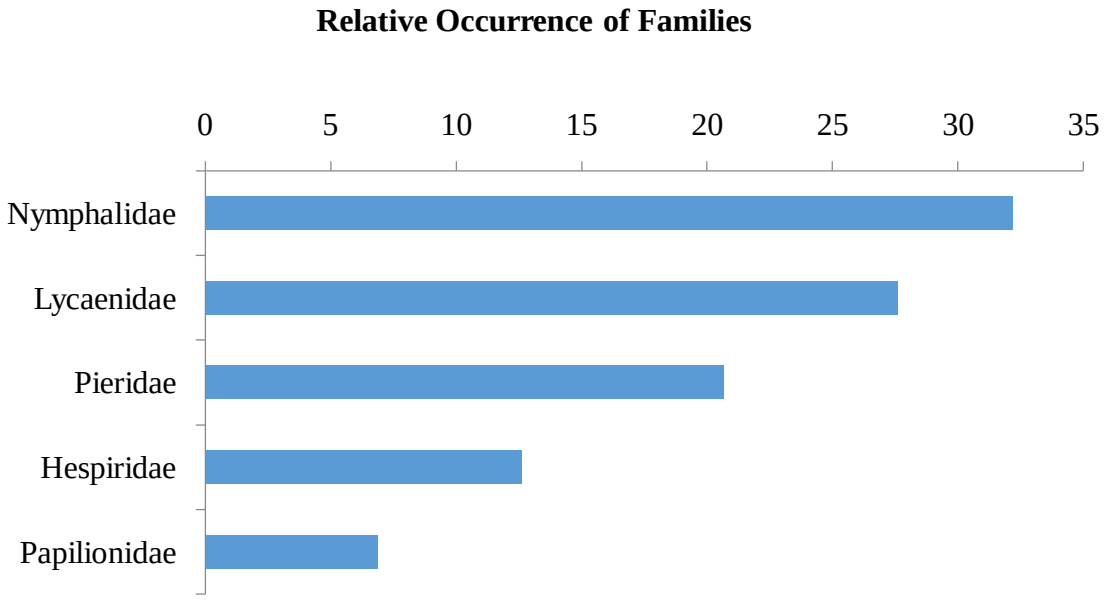


Figure 1. Relative dominance of butterfly families in the Isapur Wildlife Sanctuary, Maharashtra, India

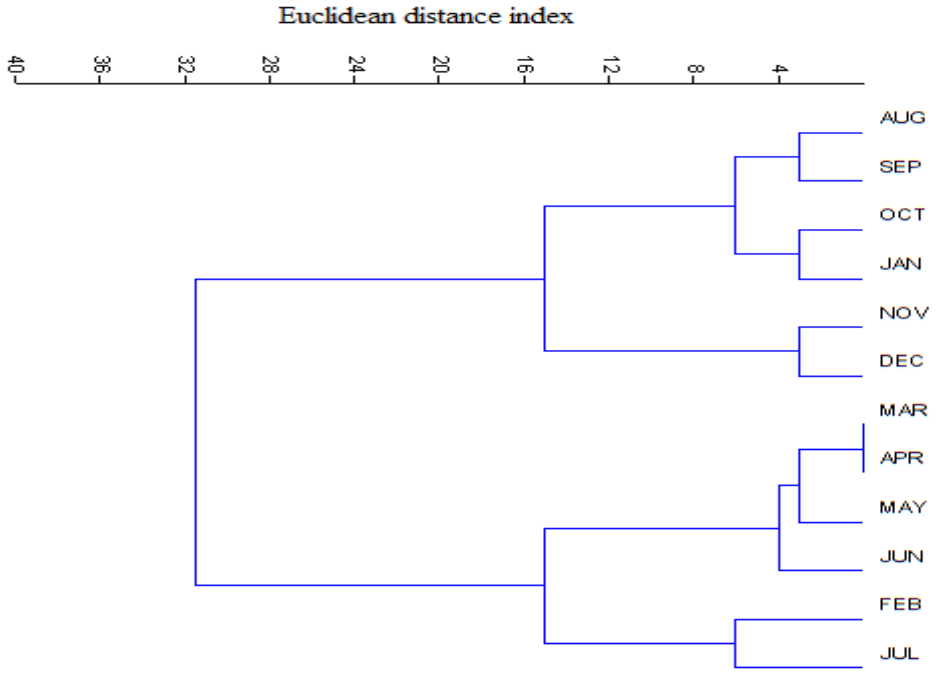


Figure 2. Dendrogram showing similarity in number of butterfly species composition among the studied month during January 2019 to December 2019

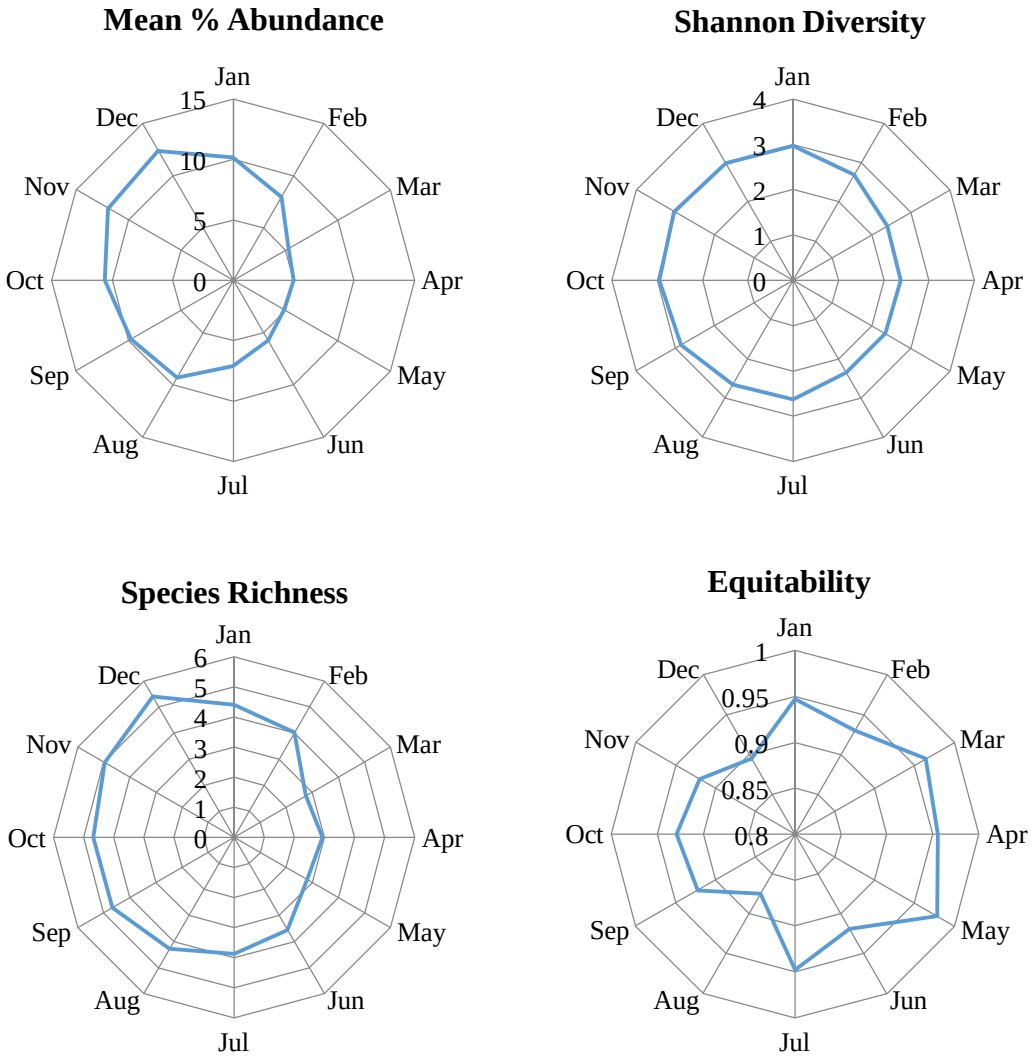


Figure 3. The values of the diversity indices in different months observed through the random sampling of butterflies in the Isapur Wildlife Sanctuary, Maharashtra, India

Discussion

The butterflies are the ecologically important creature that serves as indicators of environmental conditions (Stefanescu et al. 2004). Observations on the butterfly diversity provide the information about variations in the species richness and the abundance in relation with the vegetation along thelandscape and the species interactions(Öckinger and Smith 2006;Öckinger et al 2006; Mutmainnah and Santosa 2019). In this context, the diversity of Butterflies in the Isapur Wildlife Sanctuary, Maharashtra, India was studied during January 2019 to December 2019. The study area is bordering to the Isapur dam, largest dam in district It is dominated by the dense vegetation with variety of plant species that host the butterfly populations. The earlier studies showed that heterogeneity of the habitats in terms of the available plant species supports the rich butterfly diversity (Kuussaari et al 2007; Mukherjee et al 2015). Earlier studies on the butterfly diversity in the agricultural landscape contrast to the urban and suburban regions show that the richness increased with the availability of the green space and the heterogeneity of the habitats in terms of the available plant species (Öckinger et al, 2009; Mukherjee et al 2015). Consistent with these studies the present observation records a total of 87 species belonging to five families from study area.

The maximum number of butterfly species was recorded under family Nymphalidae, Lycaenidae followed by Pieridae, Hesperiidae

and Papilionidae. Among these 87 species Based on value of butterfly relative dominance in study area, 41.38 % species was categorized as abundant species whereas 39.08 % species was common, 5 % species was frequent, 11.49 % was occasional and 2.30 % species was rare. The rare species included *Colotis amata* and *Colotis danae*. Out of these 87 butterfly species, 14 species specified under Indian Wildlife (Protection) Act, 1972 were encountered in good numbers. The butterflies *Pachliopta hector, Castalius rosimon*and *Virachola isocrates*are placed in Schedule I Part IV, the species *Appias albino, Cepora nerissa, Hypolimnas misippus, Melanitis zitenius, Charaxes bernardus, Anthene lycaenina, Euchrysops cnejus, Lampides boeticus* and *Prosotas dubiosa*are protected under Schedule II Part II, while *Hasora vita* and *Baoris farri* are categorized as Schedule IV.

It appears that the butterfly abundance increased from monsoon to winter while decreased in the summer and pre monsoon due to possibly with the unavailability of nector and the changes in temperature and humidity of the habitats concerned. Observations on the monthly variations of butterfly encounters indicates peak from September to December while a low from January to June. The present observations remain consistent with the records and views of the butterfly species in different parts of the world (Wilson et al 2004; Tiple et al 2006; Sodhi et al 2010; Tiple 2018). The number of species observed in the present study remained similar to the observations on the species in different parts of India bearing similar landscape patterns (Roy et al 2012; Harsh2014; Saikia 2014; Mukherjee et al 2015). As revealed through the present study, atleast 87 butterfly species are available in different numbers across the study area. Dominance of the butterflies of the family Nymphalidaeis similar to thatobserved in other parts of the world (Mutmainnah and Santosa 2019).

In parity with the species diversity observed in Isapur Wildlife Sanctuary of Maharashtra, India, it may be assumed that the butterflies carry out diverse functional roles for the sustenance ofthe ecosystems. The richness in species composition in studyareawasalso prominent in present investigation. The availability of the vegetation, seasonal wetlands and allied factors that render stability to the butterfly population and assemblages in the landscapes are possibly important contributors to the observed variations in the butterfly species observed in the present study. The observations on the diversity of the butterflies in the study area suggested that the conservation management is required to ensure sustenance of ecosystem services derived from the butterflies.

The present diversity study is confined to a limited area and selected habitats. There is, in the future, a chance of more species being reported because of few pockets and habitats in the studied area requiring more extensive exploration.

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